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Door Protection Requirement Updates in ANSI A17.1-2019 / CSA B44-19

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Passenger elevator door protection requirements are about to change with the release of ANSI A17.1-2019 / CSA B44-19. New requirements are introduced for reopening devices used in power-operated horizontally sliding doors. These requirements better address the safety of people and reduce damage caused by objects hitting elevator doors. To better understand why these changes have been implemented, it is useful to understand current door protection requirements and some of the challenges passengers still face when they use elevators today.

When elevators became commercially feasible, building owners utilized elevator attendants (people) to actually run each individual elevator and ensure that elevator doors did not close on passengers or objects entering the elevator cab. Over time, however, technology started to replace what had become known as “attended operation,” primarily due to the expense of needing personnel available to run many elevators seven days a week, some with 24-hour operation.

Relative to door protection, one of the first technologies used was the mechanical safety edge – sometimes referred to as door bumpers or door buffers. These devices are attached to moving elevator cab doors and when they come in contact with a person or object are depressed, causing the change of state of an associated electrical contact that, in turn, generates a reopen signal back to the elevator control. Mechanical safety edges generally cover the full door opening but require contact with the person or object in order to cause this reopen signal to be generated (i.e. a person or object must be “hit” by the mechanical safety edge).

To address this “contact” requirement, several elevator manufacturers used the mechanical safety edge with one or two single beam photoelectric sensors added to the safety circuit. In fact, CEDES was born in 1986 when our founder was asked to develop this single beam solution for a major elevator manufacturer. These photoelectric sensors were located on the elevator cab near or on the cab door(s) and were used to detect the presence of a leg or body in the opening so that detection could occur prior to impact by the mechanical safety edge. In this configuration, there are still only one or two points of non-contact detection, and hence body parts (e.g. head) could still get “hit” by the mechanical safety edge.

This progressed to using a light curtain – a device where many photoelectric sensors are mounted in a single housing and operate as a single system. A light curtain is still mounted on the elevator cab door(s) but replaces the mechanical safety edge and is a completely non-contact solution because the detection means does not require a person or object to make contact with the device to generate the reopening signal. When one or more of the light beams become interrupted, the door reopen signal is automatically generated. Over the years, this solution has become the de facto standard for elevators in North America.

All of these solutions fulfill the requirements defined in Section 2.13.5 of ANSI A17.1-2016 / CSA B44-16, the Safety Code for Elevators and Escalators (the “Code”), as well as earlier versions of the Code. The 2016 Code, and previous versions, basically require that when a “reopening device” is used in power-operated horizontally sliding car door applications, it must be effective for “substantially the full vertical opening of the door.”

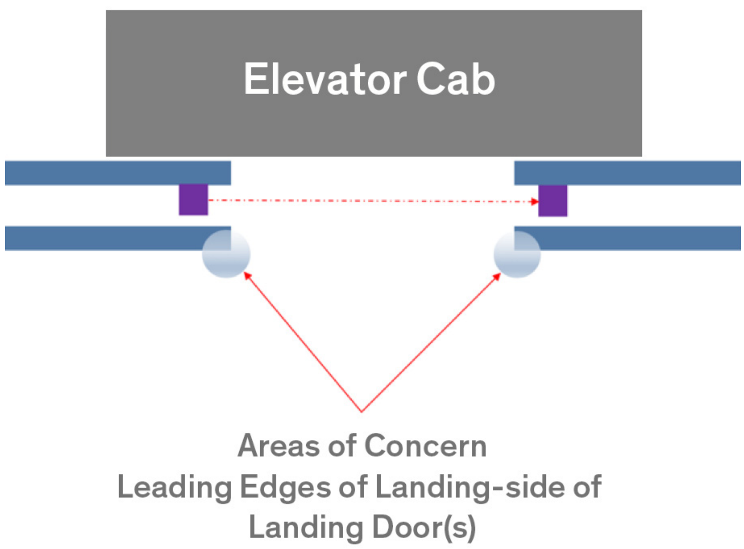
With the changes I am about to describe, I know that there are some in the elevator industry that will say why fix something that isn’t broken. Unfortunately, the injury data does not back this sentiment, and marked improvements are still needed to reduce the number of injuries that still occur during elevator door closing.

Three studies were performed by the Department of Public Health at the Indiana University School of Medicine that provide detail on injuries still occurring in passenger elevator applications. All studies utilized the United States Consumer Product Safety Commission (CPSC)[1] National Electronic Injury Surveillance System (NEISS), a database that provides injury statistics based on emergency room visits at one of 100 NEISS-designated hospitals.

The NEISS database does not include injuries that result in death nor injuries that are only treated at the scene of an incident. It only includes injuries associated with emergency room visits and hence it is likely that the total number of incidents that occurred in the referenced times frames below are actually underreported.

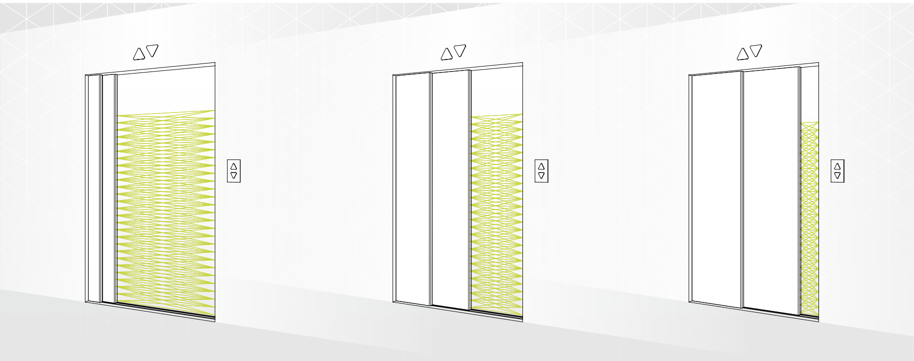
- For children from 0 to 19 years of age, NEISS data indicated that statistically 18,750 elevator injuries (64.5%) were due to elevator door closing on a body part of the 29,030 total injuries estimated to have occurred between 1990 and 2004 (O’Neill, et. Al., 2007)[2] ;
- For adults from 20 to 64 years old, NEISS data indicated that statistically 23,659 elevator injuries (42.5%) were due to elevator door closing on a body part of the 55,614 total injuries estimated to have occurred between 1990 and 2002 (Morrison-Ibrahim, Between 2010-2012)[3] ; and
- For adults 65 years old and older, NEISS data indicated that statistically 15,166 elevator injuries (33.8%) were due to elevator door closing on a body part or walker wedged in door of the 44,870 total injuries estimated to have occurred between 1990 and 2006 (Steele, et. Al., 2010)[4].

Using this data, the number of emergency room visits attributed to an elevator door(s) closing on a body part or a walker being wedged in the elevator door(s) is nearly 4,000 annually and additional hazards, such as the leading edge of the landing side of the landing door, still need to be addressed.



Since elevator safety is the focus of the Code, the Ad Hoc Committee on Door Protection has been working for more than ten years to develop additional requirements that will be included in the 2019 Code update. These updates follow the Ad Hoc Committee’s work published back in the 2008 Code addendum for power closing of vertically sliding doors and gates. Once those updates were published, the Ad Hoc Committee turned their focus to reopening devices for power-operated horizontally sliding car doors and gates, leading to new performance and product design requirements. By including design requirements for manufacturers, testing requirements needed by Authorities Having Jurisdiction (AHJs) and end-users were simplified, focusing on ensuring basic operation is fulfilled rather than requiring a battery of tests related to position, target color, target size, target shape, etc. for each elevator application.

The CEDES CabSafe™ system will be used to highlight several design requirements necessary to comply with the 2019 Code. To ensure correct interpretation of the code language, CEDES will also have their CabSafe™ system third-party certified by an Accredited Elevator/Escalator Certification Organization (AECO) after the 2019 Code is officially published.



CabSafe™ 2D

CabSafe™ 3D

The CEDES CabSafe™ system consists of three parts:

- The CabSafe™ 2D Light Curtain that detects objects between the elevator cab doors,
- The CabSafe™ 3D Time-of-Flight (TOF) sensor to detect objects approaching the entrance area, and
- The CabSafe™ Controller.

The CabSafe™ 2D Light Curtain consists of a transmitter and a receiver that form a planar detection field of criss-cross beams between them. The system is similar to a "traditional" light curtain in that it detects objects between the elevator cab doors, but there are several key differences that ensure 2019 Code compliance. These include:

- Continuous testing occurs, including after the elevator doors have reached their fully open position and prior to the initiation of a door closure, to ensure that the CabSafe™ 2D is operating correctly and able to detect the target objects defined by the Code.
- In dynamic-mounted systems (light curtain travels with door(s)), the receiver provides door position information e.g. when the doors have reached full-open or have closed to a point where the CabSafe™ 3D Time-of-Flight (TOF) sensor can be rendered inoperative.
- In static-mounted systems (light curtains do not move with the doors), a separate signal provides position information (e.g. signal from elevator control or a magnetic switch).

The CabSafe™ 3D Time-of-Flight (TOF) sensor monitors the entrance area for people or objects that are approaching the elevator cab doors. Features include:

- The sensor is transom mounted and is available with surface mount or flush mount hardware.
- Flush mount brackets extend down from the transom only a few millimeters and may utilize a veneer (e.g. stainless or bronze) to match the transom material.
- The detection field is rectangular in shape and makes 9,600 individual distance measurements within the detection field multiple times each second.
- Objects moving toward the cab entrance at speeds greater than 0.20 m/s (8 in/s) generate a reopen signal. This value is chosen based on published data where "supervised walker ambulation" has been defined as walking speeds $\geq$ 0.340 m/s (1.14 ft/s) and $<$ 0.57 m/s (1.87 ft/s).[5,6] Objects at slower speeds are considered to be stationary.
- Stationary objects can be ignored (e.g. plants, people standing in front of the entrance) since the closing door(s) does not pose a hazard unless movement toward the entrance occurs.
- Continuous testing occurs, including after the elevator doors have reached their fully open position and prior to the

initiation of a door closure, to ensure that the CabSafe™ 3D is operating correctly and able to detect the target objects defined by the Code.

The TOF technology used in the CabSafe™ 3D was chosen so that users gain several additional benefits, including:

- The field of view is large and flexible enough to provide robust performance in new installations and modernization applications when landing doors may not be perfectly synchronized with the elevator cab doors (e.g. landing door leads elevator cab door).
- The detection area exceeds the requirements defined by the Code by having a well-defined rectangular shaped detection field in front of the landing doors (i.e. much more than a single point on the moving line(s) located 9 inches in front of the landing side of the landing door(s) and extending from 9 inches to 20 inches out from the leading edge of the landing side of the landing door(s) and transits with the closing door(s) as defined by the Code).
- The CabSafe 3D detection area is stable and does not extend excessively into the lobby (e.g. we have all seen pedestrian doors that use ultrasonic or radar sensors false-trigger due to a person or object passing near the door, but not intending to enter).
- Infrared technology is not disturbed by metal objects (e.g. elevator doors or metal carts traveling nearby), is mature and has robust ambient light immunity.
- The detection field is continuously tested, including when the doors have reached their fully open position and prior to the initiation of door close, even when no objects are present in the detection field (because the CabSafe™ 3D sees the floor without needing a moving object in the detection field). And,
- TOF technology is not subject to upcoming FCC limitations for ultra-wide band (UWB) frequencies that are often required to have stable operation and prevent interference in other radar-based solutions.

The CabSafe™ Controller brings all the system components together by monitoring the CabSafe™ 2D and CabSafe™ 3D TOF sensor and provide a single output (solid state or relay-based) that represents the state of the system. Requirements defined for rendering the approaching object detection inoperative are also managed by the CabSafe™ controller, making the system robust and as efficient as possible. Additionally, the CabSafe™ controller provides a means for configuring the CabSafe™ 3D TOF sensor detection field in center-opening, left-opening and right-opening elevator door applications.

With the upcoming changes to the Elevator and Escalator Safety Code, the new requirements for reopening devices that are used in power-operated horizontally sliding doors can be easily fulfilled using devices such as the CEDES CabSafe™. Since most of the upcoming Code changes discussed are design requirements, ensuring that the device used can be implemented easily. Third-party party AECO certification gives users the confidence that their door protection system is Code compliant, allowing basic functions to be easily checked and making maintenance control programs (MCO simple to implement without the need for test objects nor complicated test procedures.

About the author:

James O'Laughlin has served as a member of the ANSI A17.1 / CSA B44 Ad Hoc Committee on Door Protection since 2013 providing background information on the current state of sensor technology capabilities and input into the latest door protection requirements. O'Laughlin is presently the North American Technical Sales Manager for CEDES Corporation of America in Minneapolis, Minnesota and serves as part of their senior management team. As an electrical engineering (BSEE) graduate from Minnesota State University – Mankato, he has more than 30 years experience in product management, product marketing and technical support. He currently focuses on sensors used in the elevators, doors, gates, and warehouse management market sectors.

[1] https://www.cpsc.gov/Research--Statistics/NEISS-Injury-Data

[2] Joseph O'Neil, MD, MPH, Gregory K. Steele, DrPH, MPH, Carrie Huisingh, MPH, and Gary A. Smith, MD, DrPH, Department of Public Health, Indiana University School of Medicine. Elevator-Related Injuries to Children in the United States, 1990 Through 2004. Clinical Pediatrics. September 2007. Sage Publications. Pages 619-625. https://journals.sagepub.com/doi/abs/10.1177/0009922807300232

[3] Deborah E. Morrison-Ibrahim, Department of Public Health, Indiana University School of Medicine. *Retrospective Analysis of Elevator Related Injuries in Ages 20-64, 1990-2002.* Unpublished between 2010-2012. Study obtained from Dr. Gregory Steele on March 4, 2013. Pages 1-35.

[4] Gregory K. Steele, DrPH, MPH, Joseph O'Neil, MD, MPH, Carrie Huisingh, MPH, and Gary A. Smith, MD, DrPH. Department of Public Health, Indiana University School of Medicine. *Elevator-Related Injuries to Older Adults in the United States, 1990 to 2006. The Journal of TRAUMA® Injury, Infection, and Critical Care*. January 2010. Lippincott, Williams & Wilkins. Pages 188-192. https://journals.lww.com/jtrauma/

Abstract/2010/01000/Elevator_Related_Injuries_to_Older_Adults_in_the.32.aspx

[5] James E. Graham, Steve R. Fisher, Ivonne-Marie Berge's, Yong-Fang Kuo, Glenn V. Ostir; University of Texas Medical Branch. Walking Speed Threshold for Classifying *Walking Independence in Hospitalized Older Adults*. November 1, 2010. Physical Therapy. Oxford Academic. Pages 1591-1597. https://doi.org/10.2522/ptj.20100018

[6] Hubertus J. A. van Hedel, PhD, PT, EMSCI Study Group. *Gait Speed in Relation to Categories of Functional Ambulation After Spinal Cord Injury. Neuroscience, Neurology & Psychiatry*. December 5, 2008. Sage Publications. https://doi.org/10.1177/1545968308324224